



The Mansoura experience in the treatment of idiopathic clubfoot deformity using the Ponseti technique

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The purpose of this study was to evaluate prospectively the results of the Ponseti technique in the treatment of congenital idiopathic clubfoot, to assess the factors that influenced the results and to report the complications that occurred.

Seventy one congenital idiopathic clubfeet in 45 patients were treated with serial casting performed at weekly intervals, as described by Ponseti. The mean age at presentation was 64.6 days (range : 3 to 346 days). The average follow-up period was 26.3 months (range : 24-29 months).

The results were considered good when there was no residual equinus in the hindfoot, a clear valgus position of the calcaneus, no residual internal rotation in the hindfoot and a fully restorable adduction of the forefoot by slight pressure on the medial side of the first metatarsal. A residual deformity of one of these criteria was considered to be a failure and resulted in a decision for operative treatment. Correction was obtained in 43 patients (95.5%), with 2 to 10 casts, with minimal complications.

In conclusion, the Ponseti method is a very safe, efficient treatment for correction of clubfeet that radically decreases the need for extensive surgery.

Keywords : idiopathic clubfoot ; Ponseti method ; conservative treatment ; serial casting.

INTRODUCTION

Clubfoot deformity is probably the most common (1 to 2 in 1,000 live births) congenital orthopedic condition requiring intensive treatment. It

represents a congenital dysplasia of all musculoskeletal tissues distal to the knee (6). This deformity represents a pathological condition consisting of adduction of the forefoot, inversion of the heel and equinus at the ankle. The condition has also been described as a congenital subluxation of the talo-calcaneo-navicular joint (9).

Since Hippocrates' initial description of the treatment of clubfoot deformity more than 2,000 years ago, idiopathic clubfoot has been recognized as a difficult and frustrating deformity to treat (4). Most of the orthopaedists agree that the initial treatment should be non-surgical and should be started soon after birth (6). In many institutions, various techniques of manipulation and serial casting are applied and frequently result in incomplete and defective corrections. As a result, extensive corrective surgery

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is indicated in 50% to 90% of cases, often with disturbing failures and complications. In addition, depending on the technique followed and the residual deformity, up to 47% of clubfeet undergo one or more revision surgeries (14).

The methods of conservative treatment most widely practiced and with the highest reported success at long term follow-up are the Kite/Lovell technique, the French technique and the Ponseti technique (6). Ponseti was adamant in obtaining correction non-operatively by correcting all components of the clubfoot simultaneously. Ponseti's significant departure from Kite's technique involved the realization that the calcaneus could in fact be corrected out of varus/inversion by abducting the forefoot. Ponseti felt that Kite achieved calcaneal correction only with great patience and a long treatment time by not allowing the heel to correct simultaneously with the forefoot (8,11,12,13).

Ponseti and Smoley (9) published their first report on 67 patients who were younger than 6 months and were treated by the Ponseti method in the form of serial manipulation and casting of the feet, with or without an Achilles tenotomy, followed by the use of a foot abduction orthosis (FAO) for maintenance of the correction. They demonstrated satisfactory and rapid initial correction in the majority of cases (83%) with minimal complications. However, there was a relatively high incidence of clubfoot relapse (56%) in this patient population. Most relapses were treated successfully with repeated manipulations and castings and/or anterior tibial tendon transfers. More importantly, the long-term functional and clinical results at a 30-year follow-up were excellent or good in the majority of these patients, using pain and functional limitation as the outcome criteria (3,10).

The objective of our study is to evaluate prospectively the short-term results of the Ponseti technique in treatment of clubfoot deformity, to assess the factors that may influence the results and to report the complications that may occur.

PATIENTS AND METHODS

Between August 2005 and July 2007, 71 congenital idiopathic clubfeet in 45 patients, 31 boys and 14 girls,

were treated at the outpatient clinic of the Orthopaedic department of Mansoura University, with serial casting performed at weekly intervals, as described by Ponseti (11). The mean age at presentation was 64.6 days (range : 3 to 346 days). The right side was affected in 8 patients (17.8%) and the left in 11 (24.4%); 26 patients (57.8%) had bilateral involvement. Seven patients (15.6%) had a positive family history of clubfoot deformity. Forty one children (91.1%) were full term, without complications during gestation or delivery; 4 children (8.9%) were preterm and admitted in the nursery. Twenty two (49.9%) patients had received some form of treatment before their initial visit to our department. Eleven (24.45%) had serial manipulation and adhesive plaster, and 11 (24.45%) had serial manipulation and casting, ranging from 2 to 12, with a median of 7 casts. Corrective surgery was recommended to 15 (35.5%) patients by their treating physicians.

Clubfeet which had received previous surgical treatment, were not included. All feet in this study were followed up clinically for an average period of 26.3 months (ranging from 24 to 29 months). No patient was lost to follow-up.

Technique

The first element of management is correction of the cavus deformity by positioning the forefoot in proper alignment with the hindfoot. The cavus, which is the high medial arch, is due to the pronation of the forefoot in relation to the hindfoot. Alignment of the forefoot with the hindfoot to produce a normal arch is necessary for effective abduction of the foot to correct the adductus and varus (fig 1).

The foot is manipulated next, by abducting the foot in supination with the foot stabilized by the thumb over the head of the talus, and the index of the same hand behind the fibula. The foot is abducted as far as can be done without causing discomfort to the infant. The correction is held with gentle pressure for about 60 seconds. During this phase of treatment, the adductus and varus are fully corrected (fig 2).

A major decision point in management is to determine when sufficient correction has been obtained before performing a percutaneous tenotomy to gain dorsiflexion and to complete the treatment. This point is reached when the anterior calcaneus can be abducted from underneath the talus. This abduction allows the foot to be safely dorsiflexed without crushing the talus between the calcaneus and tibia. The tenotomy is performed in the outpatient clinic under local anaesthesia. A well-molded

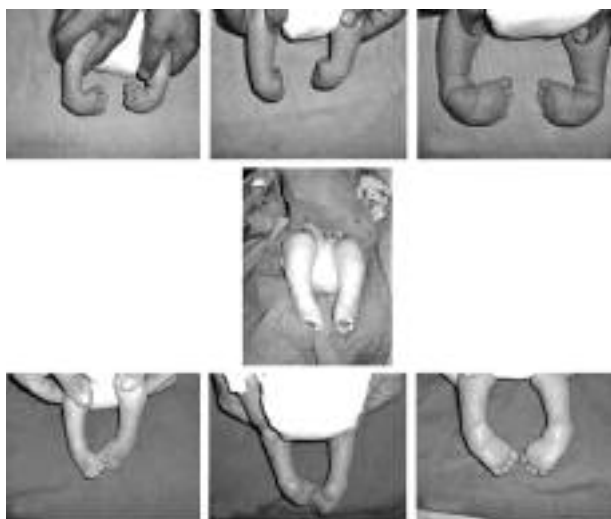


Fig. 1. — Correction of the cavus deformity



Fig. 2. — Correction of adductus and varus



Fig. 3. — Post-tenotomy cast

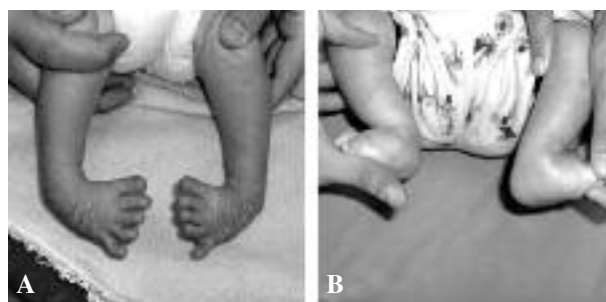


Fig. 4. — (A) 16-day-old male with bilateral clubfeet at presentation ; (B) After removal of posttenotomy cast.

long-leg plaster cast is then applied, maintaining the foot in maximum dorsiflexion and in about 70° of external rotation. The last cast is left in place for 3 weeks to allow tendon healing (fig 3).

After 3 weeks, the cast is removed. Thirty degrees of dorsiflexion is now possible, the foot is well corrected, and the operative scar is minimal. The foot is ready for bracing (fig 4).

The brace is applied immediately after the last cast is removed, 3 weeks after tenotomy. The brace consists of open toe high-top straight last shoes attached to a bar (Denis Browne bar). The brace should be worn full time (day and night) for the first 3 months after the last cast is removed. After that, the child should wear the brace for 12 hours at night and 2 to 4 hours in the middle of the day for a total of 14 to 16 hours during each 24-hour period. This protocol continues until the child is 3 to 4 years of age. Parent self-report on brace wear was used to assess compliance. Noncompliance was defined when the foot abduction brace was not used for at least 10 hours a day (fig 5).



Fig. 5. — Dennis Browne bar (foot abduction orthosis)

A relapse was defined as the reappearance of any of the components of the deformity, including cavus, adductus, varus, and/or equinus. Relapses after initial correction are treated with additional manipulation and serial casting in marked foot abduction. A second Achilles tenotomy/lengthening may be indicated if dorsiflexion of the ankle is less than 15 degrees.

RESULTS

The results were evaluated and considered good when there was no residual equinus in the hindfoot, a clear valgus position of the calcaneus, no residual endorotation in the hindfoot and a fully restorable adduction of the forefoot by slight pressure on the medial side of the first metatarsal. Residual deformity of one of these criteria was considered to be a failure and resulted in a decision for operative treatment.

Correction was obtained in all but 2 patients (95.5%). Correction was obtained with 2 to 10 casts (fig 6).

Tenotomies were performed on 55 of the 71 feet, or 77.5%. The mean number of casts required was significantly greater ($p < 0.0001$) for the group that required a tenotomy : 4.75 casts (range 3-10) versus 3 casts (range 2-4) in the non tenotomy group (fig 7).

The average ankle dorsiflexion in the tenotomy group was 22.2° (SD : 8.4) and in the non tenotomy

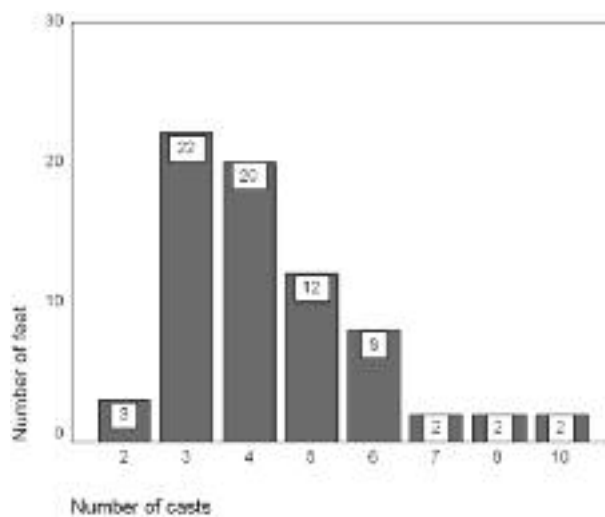


Fig. 6. — Number of casts

group 24.4° (SD : 4.8) with no statistically significant difference ($p = 0.322$). The majority of patients started walking at an age of 13 months (range : 9-17 months) (fig 8).

Of the 45 patients treated, 40 (88.9%) were compliant and 5 (11.1%) were noncompliant in wearing the Dennis Browne bar.

Twelve patients (26.7%) or 21 feet (29.6%) showed a relapse after initial successful treatment. Relapse of the deformity was not significantly related to the age at presentation, a previous



Fig. 7. — (A) 91-day-old female with bilateral idiopathic clubfeet ; (B) Immediately after tenotomy showing fully corrected feet ; (C) After 25 months follow-up.

unsuccessful treatment at another institution, nor the number of casts required for correction (used as a measure of severity). Relapses were however significantly associated with noncompliance with the foot-abduction brace ($p < 0.0001$).

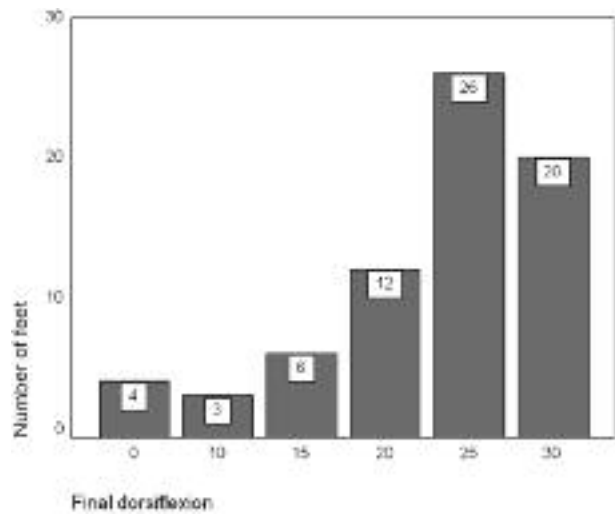


Fig. 8. — Average ankle dorsiflexion at the last follow-up was 22.6° (range : 0–30°).

Recurrent deformities were treated with a second series of manipulation and casting : 4 feet required only 1 cast, 4 feet required 2 casts, 11 feet required 3 casts and 2 feet required 6 casts, followed by the use of the foot-abduction brace. Thirteen feet required a second tendo Achilles tenotomy.

Only 2 (4.5%) patients (4 feet) required corrective surgery after treatment by the Ponseti method. They responded well to posterior release. It is interesting that of the 13 patients previously indicated for corrective surgery by the local physician, only 2 went on to surgery after treatment by the Ponseti method (fig 9).

Two (4.5%) patients had a cast complication including erythema, blisters, maceration and slight swelling of the forefoot and toes. All these complications were attributed to a deficient casting technique and resolved completely after rest for one week. One patient showed midfoot hyperabduction. This deformity corrected gradually with bracing (fig 10). Some patients with marked equinus presented with a downward slippage of the cast, secondary to the shape of the infant's extremity. This could be avoided by application of well-molded long-leg plaster casts. Three (6.6%) patients had cast saw injuries. By switching to the cast knife technique described by Ponseti, these injuries were



Fig. 9. — (A) This patient presented to us for treatment at 2 and a half months ; (B) After application of 10 casts and of a Dennis Browne bar for 7 months with residual equinus and heel varus ; (C) Immediately after posterior release showing fully corrected feet ; (D) After 28 months follow-up.

eliminated. Most parents reported difficulties in keeping the shoes (Denis Browne bar) on, with subsequent slippage of the foot. This problem could be avoided by adequate bracing. No infections, skin necrosis, neurovascular compromise, nor profuse post-tenotomy bleeding were observed.

DISCUSSION

Since Hippocrates' initial description of the treatment of clubfoot more than 2,000 years ago, idiopathic clubfoot has been recognized as a difficult and frustrating deformity to treat. For those who used the Kite technique, a common clinical scenario involved many months of weekly serial manipulation and casting to obtain only a partial correction of the deformity. Feet not responding to the manipulations were described as "resistant" and they subsequently underwent extensive corrective surgery (4).

A similar experience has been reported using the French method. Several reports have been pub-



Fig. 10. — (A) Midfoot hyperabduction ; (B) Gradual correction with bracing.

lished on the intermediate-term results, showing correction of the deformity in 50% to 63% of the patients (2). However, there are several concerns with this method. First, the method requires a great deal of time both from the family and the treating physiotherapist, with success directly related to the skills and expertise of the therapist. Second, cooperation and compliance of the families are essential for this treatment program to be effective. Third, there have been safety concerns about the Continuous Passive Motion (CPM) machine, with the development of pressure sores, ankle strains, torque of the tibia, and falls from the crib. Finally, economic concerns are an important factor : this technique requires one member of the family to make daily visits to the clinic (5).

The major concern in the operative treatment of congenital clubfoot is the functional outcome. Numerous reports document good results for the first 10 years of life. However, as the child with a clubfoot becomes an adult, the functional results often deteriorate. Open surgical release often leads to scarring and stiffening of the ankle, with resulting limitation of motion and strength. Aronson and Puskarich (1) studied the disability associated with various clubfoot treatment options. Their results showed that patients who underwent casting only and patients who had additional heel cord lengthening had the least deformity and disability. However, patients who had undergone posteromedial release had reduced ankle plantarflexion motion and diminished push-off strength (1). Our patients who were treated with the Ponseti method had much better

ankle range of motion, both in dorsiflexion and plantarflexion.

Our study clearly demonstrates that with the use of the Ponseti method, 95.5% of patients with idiopathic clubfeet can be corrected without the need for extensive corrective surgery, in a relatively short period of time (average 21 days from first cast to tenotomy). In addition, no increased difficulty was found in correcting the deformity in children up to the age of 12 months, or in patients who previously had non-surgical corrective attempts. Although this "Ponseti" group represented our learning curve with this method, we are very satisfied with the initial results. Only 2 of our patients treated with the Ponseti method required posterior release, and this was attributed to noncompliance with the foot abduction orthosis regimen. At the end of casting, these feet were well corrected. However, the parents were not compliant with the derotation splinting, and the deformity relapsed. Another series of manipulations and casts were applied, which corrected the recurrent deformity, but even then, the parents did not comply. Finally, posterior release was performed.

Herzenberg *et al* (7) recently reported good results in their institution. They evaluated 27 patients (34 clubfeet) after serial manipulation and casting following the Ponseti method. Only 1 (3%) clubfoot that was treated by the Ponseti method required extensive corrective surgery compared with 32 (94%) in the control group. In addition, a significant decrease in the range of motion in patients who were treated surgically was found compared with those who were treated by the Ponseti method.

Tenotomy of the Achilles tendon is an integral part of Ponseti's technique for the treatment of clubfeet. This study was an attempt to determine which factors might predict the need for a tenotomy at the onset of treatment and also to determine the results of its use in relation to those feet not requiring tenotomy. Further evidence that the likelihood of tenotomy relates to the overall rigidity of the deformity, rather than just its absolute severity, lies in the fact that the feet that had tenotomies required significantly more casts than those that did not. It follows that the feet ultimately requiring tenotomies were in fact stiffer during the entire casting process

in addition to being more severely deformed at the onset. Their response to manipulation and casting appears to have been slower and less easy.

Perhaps the most important conclusion to be drawn from this study is the recognition that feet requiring tenotomies were equally well corrected at the end of casting as those that did not require tenotomies. This conclusion reinforces the notion that even severe idiopathic clubfeet can be successfully treated using a proper application of the Ponseti technique and the need for a tenotomy does not suggest a poorer result.

The proper use of this technique can be logically divided into two phases. First is the correction phase, during which the deformity is corrected by serial manipulation and casting. The second phase is the maintenance phase, during which the correction obtained by the casts is maintained in the growing foot. During this phase there is a risk of recurrence that persists over the first several years of life. When a recurrence occurs, it often requires additional treatment, which may consist of further casting or surgery. To minimize the recurrence rate, Ponseti recommended that once the correction was obtained with the casts, the feet should be placed into the foot abduction orthosis, which should be used for 3 to 4 years. Derotation splinting after the casting period seems to be crucial to avoid relapse of the treated foot and should be administered by any means. A longer follow-up study of our patients is needed to evaluate final outcomes.

Our study has several limitations. First, some patients were treated previously and referred for additional treatment. Therefore, we have no information regarding initial severity. Also, we do not know the precise number or sorts of manipulations and castings performed because we relied mainly on information from the parents. Therefore, we can draw no conclusions regarding whether the treatment failed owing to the deformity or to the treatment. Another limitation of this study is clearly the duration of follow-up (average 26.3 months). Although we were able to recognize the early recurrences in the noncompliant group, it is possible that recurrences could occur later on in the compliant group, either during the period of part-time use of the bar or after the bar is discontinued.

CONCLUSION

In conclusion, the Ponseti method is a very safe, efficient treatment for the correction of clubfoot, that radically decreases the need for extensive corrective surgery. Furthermore, it can be used successfully in children up to one year of age when no previous surgical treatment has been attempted. The decline in extensive clubfoot surgery should encourage national efforts to make this method the golden standard in the treatment of congenital idiopathic clubfoot. Educational programs should be targeted to primary care physicians to increase awareness of the Ponseti method and its excellent results so that they can advise families accordingly. Physicians who adopt the Ponseti method will feel rewarded by the satisfaction of successfully correcting what traditionally has been a very frustrating deformity to treat.

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